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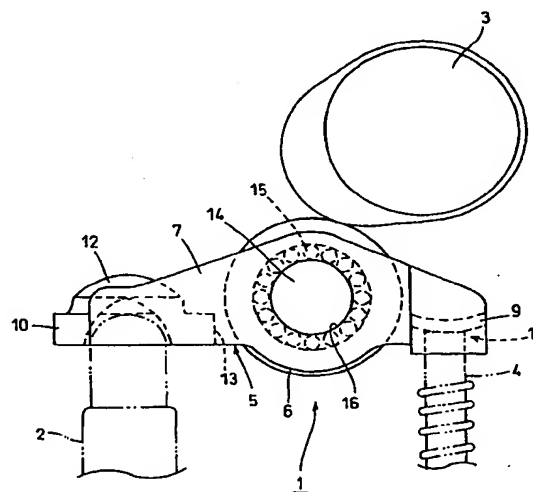
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(54) Rocker arm and method of fabricating rocker arm body

(57) A rocker arm, which opens and closes a valve tilted by a cam and provided to a cylinder head, has a body made of sheet metal. The body is constituted in such a manner that one metal plate is bent into a substantially U shape so that a pair of opposed side walls and connecting walls for connecting the side walls are provided. A reverse concave shaped valve fitting section is provided to the connecting walls of the body by press working including a non-uniform section process due to plastic flow.

FIG. 1



Description

BACKGROUND OF THE INVENTION

Field of the Invention

[0001] The present invention relates to a rocker arm for opening and closing a valve tilted by a cam and provided to a cylinder head and a fabricating method thereof. More specifically, the present invention relates to the rocker arm having a body made of sheet metal and a fabricating method of the body.

Description of the Related Art

[0002] Such a rocker arm is disclosed in, for example, Japanese Patent Application Laid-Open No. 4-259611 (1992). This rocker arm is of an end pivot type which is tilted by a cam with its one end of the longitudinal direction being a supporting point and opens and closes a valve. Moreover, a roller is mounted to a body of the rocker arm. The body has a pair of opposed side walls and a connecting wall which connects the side walls. These walls are formed by bending one metal plate into a U-shape. A valve fitting section is provided in one end area of the longitudinal direction of the connecting wall, and a pivot receiver is provided in the other end area of the longitudinal direction of the connecting wall. An upper end of the valve is fitted into the valve fitting section, and an upper end of a pivot section provided to a cylinder head is fitted into the pivot receiver.

[0003] The roller is supported rotatively to the pair of side walls via a supporting shaft on the body in a state that a part of the roller is protruded from a through hole provided in a middle portion of the longitudinal direction on the connecting wall.

[0004] In this rocker arm, the valve fitting section of the body is obtained in the following manner. The body is bent so as to have a substantially U-shaped section, and the one connecting wall of the body is pushed up to a halfway position of the up-and-down direction of the pair of side walls so as to be bent into a reverse M-shape viewed from the end surface.

[0005] In the prior example, the valve fitting section of the body is obtained by forcibly bending the body into the reverse M shape. For this reason, as shown in Figs. 8A through 8C, for example, crazing which causes lowering of strength and sink mark which causes lowering of shape accuracy easily occur on an outer surface of the bent section of the pair of side walls 51 and 52 and the connecting wall 53. Incidentally, the sink mark scatters a width dimension W of the valve fitting section 50, namely, increases a generation rate of defective products.

SUMMARY OF THE INVENTION

[0006] Therefore, it is an object of the present

invention to provide a rocker arm which has a form such that a valve fitting section formed on a body made of sheet metal can be processed without generation of defects such as crazing and sink mark and relates to a method of fabricating the body of the rocker arm.

[0007] The other objects features and advantages of the invention will become clear from the followings.

[0008] A rocker arm of the present invention for opening and closing a valve tilted by a cam and provided to a cylinder head has a body made of sheet metal which is obtained by bending one metal plate into a substantially U shape so as to form a pair of opposed side walls and connecting walls for connecting the side walls. A reverse concave shaped valve fitting section is provided to the connecting walls of the body by press working including a non-uniform section process due to plastic flow.

[0009] According to the rocker arm of the present invention, the valve fitting section of the body is obtained not by the bending process but by press working including the non-uniform section process. For this reason, crazing and sink mark do not occur, and a width dimension of the valve fitting section can be managed accurately.

[0010] The rocker arm of the present invention is preferably constituted so that the connecting walls have an area where the valve fitting section will be formed and a circumferential section of the area, and a thickness of the area where the valve fitting section will be formed is increased by the non-uniform section process for plastically flowing the section of the circumferential section to the area where the valve fitting section will be formed, and the valve fitting section is provided in the thickened area where the valve fitting section will be formed.

[0011] The rocker arm of the present invention is preferably constituted so that the connecting wall has a pair of protruded walls, and the protruded walls are protruded by the non-uniform section process for plastically flowing the sections of the side walls, and inner spaces of the protruded sections are the reverse concave shaped valve fitting section.

[0012] A method of fabricating a rocker arm body according to the present invention, the body being made of sheet metal and being provided with a pair of opposed side walls and connecting walls for connecting the side walls, the rocker arm opening and closing a valve tilted by a cam and provided to a cylinder head, includes: the first step of obtaining a developed form of the body from one metal plate; and the second step of forming a reverse concave-shaped valve fitting section on the connecting walls of the body with developed form by means of press working including a non-uniform section process due to plastic flow.

[0013] According to the fabricating method of the present invention, since the valve fitting section of the body is formed by press working including the non-uniform section process, crazing and sink mark do not

occur. For this reason, the rocker arm body where the width dimension of the valve fitting section can be managed accurately can be fabricated.

[0014] In the method of fabricating the rocker arm body according to the present invention, the second step plastically flows sections of the both sides of the connecting walls in an area where a valve fitting section will be formed to the area where the valve fitting section will be formed so as to increase a thickness of the area where the valve fitting section will be formed, and sinks the thickened areas where the valve fitting section will be formed so as to form the reverse concave-shaped valve fitting section.

[0015] In the method of fabricating the rocker arm body according to the present invention, the second step plastically flows at least sections of the side walls of the body so as to form a pair of opposed protruded walls, inner spaces of the both protruded walls is the reverse concave-shaped valve fitting section.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016] These and other objects as well as advantages of the invention will become clear by the following description of preferred embodiments of the invention with reference to the accompanying drawings, wherein:

Fig. 1 is a side view of a rocker arm according to a preferable embodiment of the present invention;
 Fig. 2 is an exploded perspective view of the rocker arm of Fig. 1;
 Fig. 3 is a plan view of the rocker arm of Fig. 1;
 Fig. 4 is a fragmentary view taken on the line (4) - (4) of Fig. 3;
 Fig. 5A is a plan view of a body with a developed form showing the fabricating steps of the rocker arm body of Fig. 1;
 Fig. 5B is a fragmentary view taken on the line Y - Y of Fig. 5A showing a non-uniform section process which is executed for a connecting wall;
 Fig. 5C is a fragmentary view taken on the line Y - Y of Fig. 5A showing the state after the non-uniform section process which is executed for the connecting wall;
 Fig. 5D is a fragmentary view taken on the line Y - Y of Fig. 5A explaining a bent form of a circumferential section of the connecting wall;
 Fig. 6 is a diagram showing another example of the processing form of a valve fitting section;
 Fig. 7A is a cross section showing another example of the processing form of the valve fitting section and explaining a half blanking process to be executed for the connecting wall by means of press working;
 Fig. 7B is a cross section corresponding to Fig. 7A explaining joining of a metal material to a protruded section of the connecting wall;
 Fig. 8A is a front view showing a main section of the

body having the side walls and the connecting wall and explaining a defect of a prior rocker arm.

Fig. 8B is a bottom view of the main section of the body of Fig. 8A; and

Fig. 8C is a fragmentary view taken on the line X - X of Fig. 8A.

[0017] In all these figures, like components are indicated by the same numerals.

DETAILED DESCRIPTION OF THE INVENTION

[0018] There will be explained below preferable embodiments of the present invention with reference to the drawings.

[0019] As shown in Figs. 1 through 5, a rocker arm 1 is of an end pivot type which is tilted by a cam 3 with one end of a longitudinal direction supported by a rush adjuster 2 being a support and opens and closes a valve 4. The rocker arm 1 is composed of two elements, a body 5 and a roller 6.

[0020] The body 5 has a pair of opposed band-shaped side walls 7 and 8 and two connecting walls 9 and 10. A reverse concave shaped valve fitting section 11 which receives an upper end of the valve 4 is provided to the connecting wall 9 on one end of the longitudinal direction. A hemispheric convex shaped pivot receiver 12 which receives an upper end of the rush adjuster 2 is provided to the connecting wall 10 on the other end of the longitudinal direction. This structure of the body 5 is obtained by bending one metal plate so that its section becomes substantially U shape by means of press working.

[0021] In this case, the valve fitting section 11 is formed on the connecting wall 9 of the body 5 into the reverse concave shape by means of the press working which includes a non-uniform section process due to plastic flow.

[0022] The roller 6 is supported rotatively to the pair of side walls 7 and 8 on the body 5 via a supporting shaft 14 and a plurality of needle rollers 15. In the state that roller 6 is supported, its outer circumferential edge is protruded from a through hole 13 provided between the two connecting walls 9 and 10 on the body 5.

[0023] The valve fitting section 11 of the body 5 has the form such that defects such as crazing and sink mark which arise a problem in the bending process do not occur. For this reason, scattering of strength and form accuracy due to the defects can be eliminated from the rocker arm having the above structure.

[0024] There will be explained below a method of fabricating the body 5.

[0025] One metal plate A is die-cut by press working so as to have an outer form shown in Fig. 5A. At the time of this process, the through hole 13 and through holes 16 of the supporting shaft 14 are formed on necessary areas of the metal plate A.

[0026] Thereafter, as for an area A1 of the metal

plate A where the valve fitting section 11 will be formed, as shown in Fig. 5B, a circumference of the area A1 is pressurized and compressed by press working using a first bearing die B and a first embossing die C. This process makes a thickness of the circumference of the area A1 thinner than an original thickness (shown by a hypothetical line). As a result, a thickness portion which plastically flows due to the pressuring-compressing process is collected in the area A1 so that the thickness of the area A1 becomes thicker than the original thickness (in this specification, this process is the non-uniform section process).

[0027] The area A1 which is made to be thicker in such a manner is, as shown in Fig. 5C, half-blanked by press working using a second embossing die D. As a result, as shown in Fig. 5D, the valve fitting section 11 having the reverse concave shape which is sank upward is obtained. A ceiling section of an inner surface of the valve fitting section 11 is curved into a semi-arc form, and this shape is formed in such a manner that an end surface shape of the second embossing die D is transferred. Both side portions of the metal plate A is, as shown in Fig. 5D, bent by press working using a second bearing die E so as to be bent into a substantially U-shape along a broken line of Fig. 5A. As a result, the pair of side walls 7 and 8 and the connecting walls 9 and 10 are obtained.

[0028] As not shown, the hemispheric pivot receiver 12 which is protruded upward from the connecting wall 10 on the other side of the longitudinal direction is obtained by a drawing process using press working. The through holes 16 may be formed after the bending process of the side walls 7 and 8 or the pivot receiver 12 may be formed before the bending process of the side walls 7 and 8.

[0029] As explained above, the valve fitting section 11 is obtained by the half-blanking process in such a manner that the one connecting wall 9 is made to be thick and is sunk into the reverse concave shape. For this reason, the defects such as crazing and sink mark which become a problem in the forcible bending process described in the prior example do not occur, namely, the scattering of strength and form accuracy due to the defects can be eliminated. As a result, fabricating yield can be improved in the body 5 of the rocker arm 1, namely, productivity can be improved and fabricating costs can be reduced.

[0030] Furthermore, since the inner surface of the valve fitting section 11 can be obtained by shearing included in the half-blanking process, the width dimension W can be managed accurately. As a result, the operability of the valve 4 by means of the valve fitting section 11 becomes stable, namely, the stability of the operation of the valve 4 can be improved.

[0031] The present invention is not limited to the above-mentioned concrete example, and various applications and modifications can be considered.

(1) In the above concrete example, the two embossing dies C and D are used separately in the step of forming the valve fitting section 11, but single embossing die F shown in Fig. 6 can be used. Namely, one surface of each of the side walls 7 and 8 is compressed so that the thickness becomes thinner by press working using the single embossing die F. Accordingly, sections which plastically flow are gathered into cavity portions F1 of the embossing die F so that a pair of protruded walls 18 which form the reverse concave-shaped valve fitting section 11 are provided on an inner side of one surface of the connecting wall 9. In this case, since a number of the processing steps can be reduced more than the above embodiment, this is advantageous to reducing of the fabricating costs. Further, since the protruded walls 18 are formed by the cavities F1 of the embossing die F, the scattering of the form can be eliminated.

(2) In the above concrete example, the thickness of the connecting wall 9 is made to be thicker and the half-blanking process is executed so that the valve fitting section 11 is formed. However, it can be processed by a manner shown in Figs. 7. Namely, as shown in Fig. 7A, one metal plate A is bent into a substantially U shape, and the one connecting wall 9 is half-blanked by press working using a bearing die G having a concave section and an embossing die H. As a result, the one connecting wall 9 is protruded to a direction which is the same as a raising direction of the pair of side walls 7 and 8 so that the protruded section 19 is formed. Accordingly, the inner space of the protruded section 19 is sunk so that the reverse concave shaped valve fitting section 11 is formed. As shown in Fig. 7B, a metal material (wax) 20 is joined to the connecting wall 9 so as to cover the whole outer surface of the protruded section 19. In such a manner, the valve fitting section 11 has a reinforced structure.

(3) In the above concrete example, the roller 6 is supported to the supporting shaft 13 via the plurality of needle rollers 14, but it can be supported rotatively by sliding contact without using the needle rollers 14. Namely, the roller 6 can be fitted directly into the supporting shaft, or as not shown, it can be fitted therein with loose fit via a slide bearing such as a bushing.

(4) The above concrete example exemplified the end pivot type rocker arm 1, but as not shown, the present invention can be applied also to a center pivot type rocker arm.

[0032] While there has been described what is at present considered to be preferred embodiments of this invention, it will be understood that various modifications may be made therein, and it is intended to cover in the appended claims all such modifications as fall within the true spirit and the scope of this invention.

Claims

1. A rocker arm for opening and closing a valve tilted by a cam and provided to a cylinder head, said rocker arm comprising:

a body made of sheet metal which is obtained by bending one metal plate into a substantially U shape so as to form a pair of opposed side walls and connecting walls for connecting said side walls,
wherein a reverse concave shaped valve fitting section is provided to said connecting walls of said body by press working including a non-uniform section process due to plastic flow.

2. The rocker arm according to claim 1, wherein said connecting walls have an area where said valve fitting section will be formed and a circumferential section of the area, and a thickness of the area where said valve fitting section will be formed is increased by the non-uniform section process for plastically flowing the section of the circumferential section to the area where said valve fitting section will be formed,
wherein said valve fitting section is provided in the thickened area where said valve fitting section will be formed.

3. The rocker arm according to claim 1, wherein said connecting wall has a pair of protruded walls, and said protruded walls are protruded by the non-uniform section process for plastically flowing the sections of said side walls, and inner spaces of said protruded sections are said reverse concave shaped valve fitting section.

4. The rocker arm according to claim 1, wherein said body has said connecting wall on both ends of a longitudinal direction and a through hole in the middle of the longitudinal direction on both the connecting walls, and said valve fitting section is provided on said connecting wall on one end of the longitudinal direction, and a roller which abuts against said cam is provided, and said roller is supported rotatively to said both side walls of said body via a supporting shaft in a state that its part is protruded from said through holes.

5. A method of fabricating a rocker arm body made of sheet metal provided with a pair of opposed side walls and connecting walls for connecting said side walls, said rocker arm opening and closing a valve tilted by a cam and provided to a cylinder head, said method comprising:

the first step of obtaining a developed form of said body from one metal plate; and

the second step of forming a reverse concave-shaped valve fitting section on said connecting walls of said body with developed form by means of press working including a non-uniform section process due to plastic flow.

6. The method of fabricating said rocker arm body according to claim 5, wherein the second step plastically flows sections of said both sides of said connecting walls in an area where a valve fitting section will be formed to the area where said valve fitting section will be formed so as to increase a thickness of the area where said valve fitting section will be formed, and sinks the thickened areas where said valve fitting section will be formed so as to form said reverse concave-shaped valve fitting section.

7. The method of forming said rocker arm body according to claim 6, further comprising the third step of bending both the sides of the areas where said valve fitting section is formed on said connecting walls so that said both sides are raised to a direction which is the same as the sunk direction of said valve fitting section so as to form said pair of side walls.

8. The method of fabricating said rocker arm body according to claim 5, wherein the second step plastically flows at least sections of said side walls of said body so as to form a pair of opposed protruded walls, inner spaces of said both protruded walls being said reverse concave-shaped valve fitting section.

9. The method of fabricating said rocker arm body according to claim 8, further comprising the fourth step of bending both sides of areas of said connecting walls where said protruded walls are provided so that both the sides are raised to a direction which is opposite to the raised direction of said protruded walls so as to obtain said pair of side walls.

FIG. 1

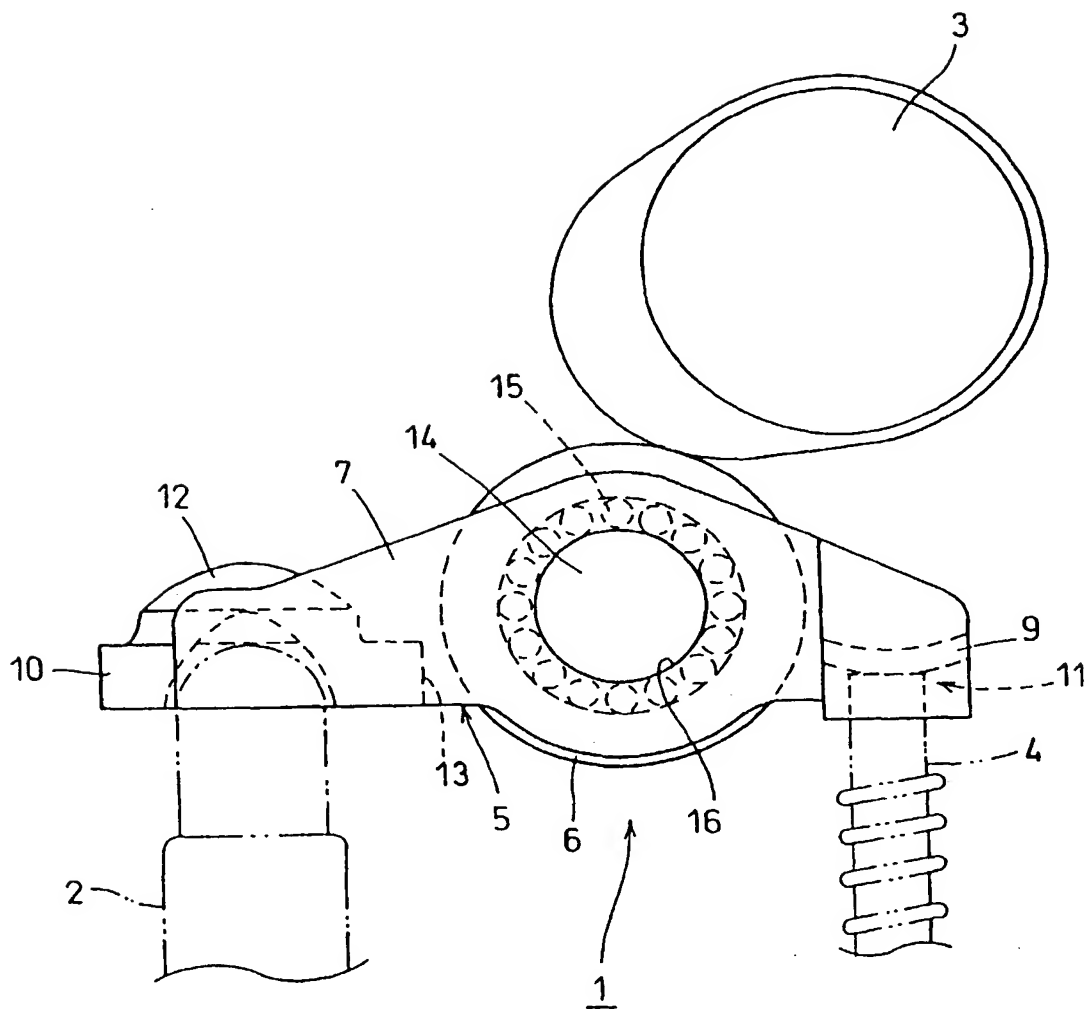


FIG. 2

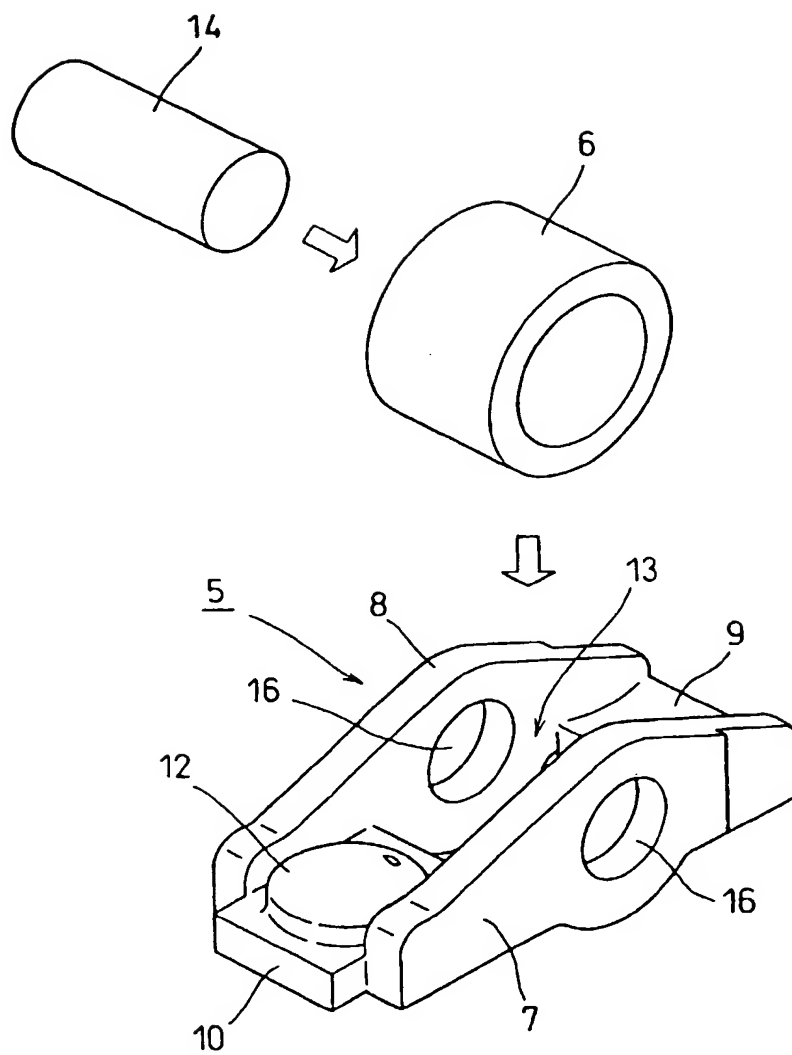


FIG. 3

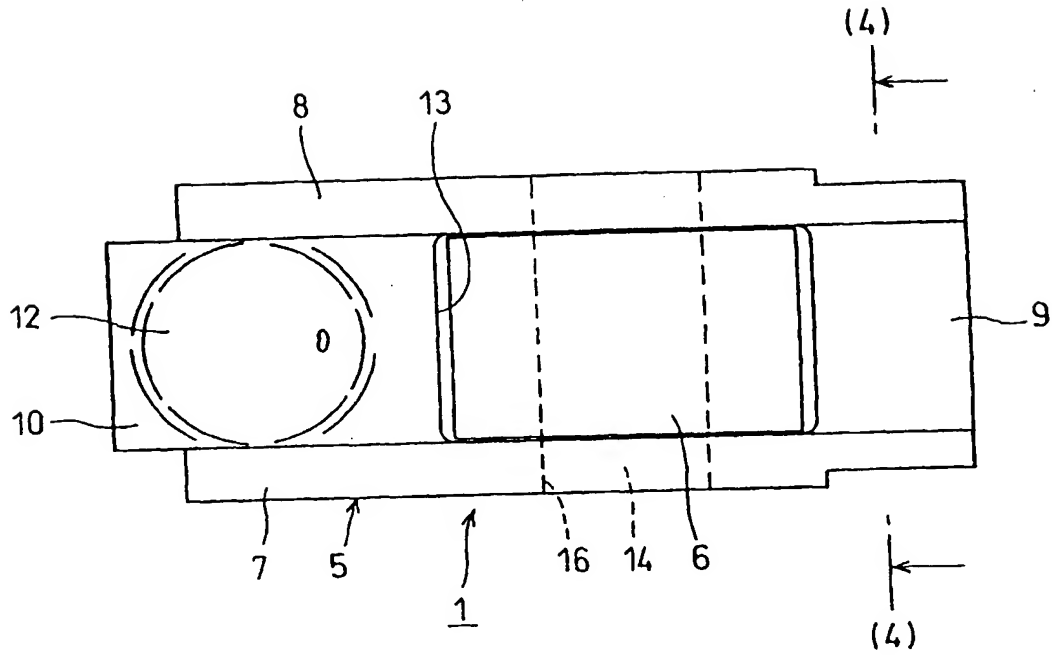


FIG. 4

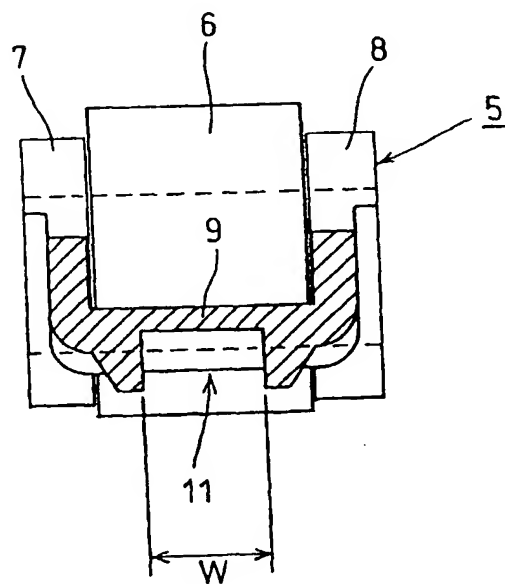


FIG. 5A

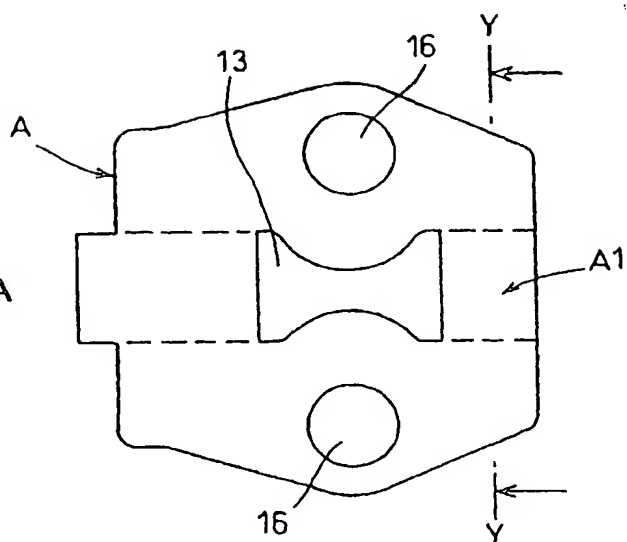


FIG. 5B

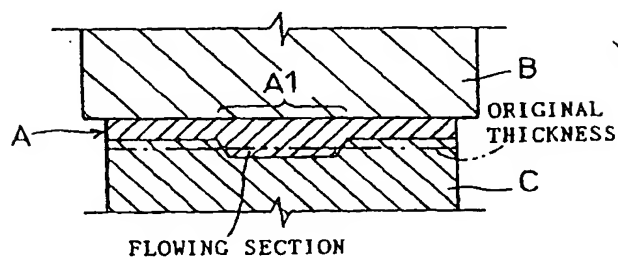


FIG. 5C

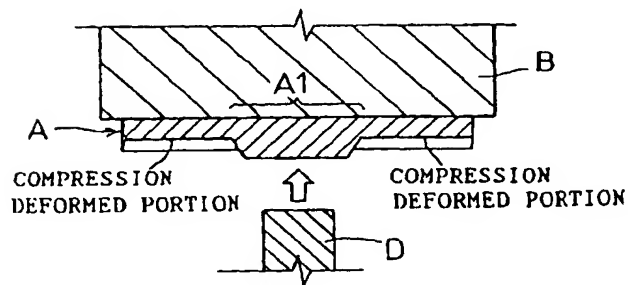
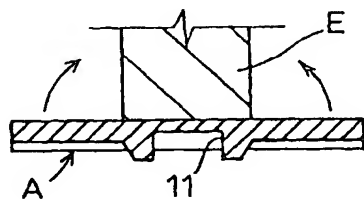


FIG. 5D



FRAGMENTAL VIEW
TAKEN ON THE LINE
Y-Y OF FIG. 5A

FIG. 8A

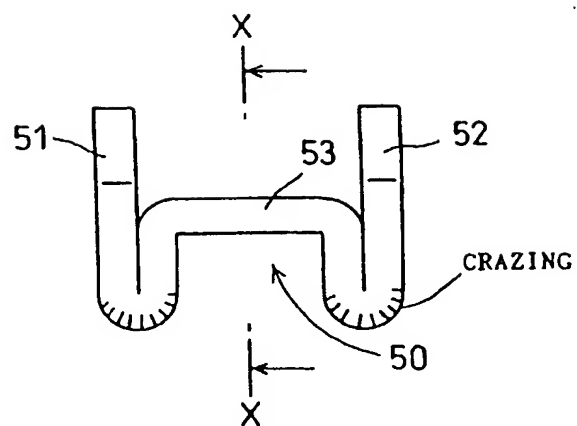


FIG. 8B

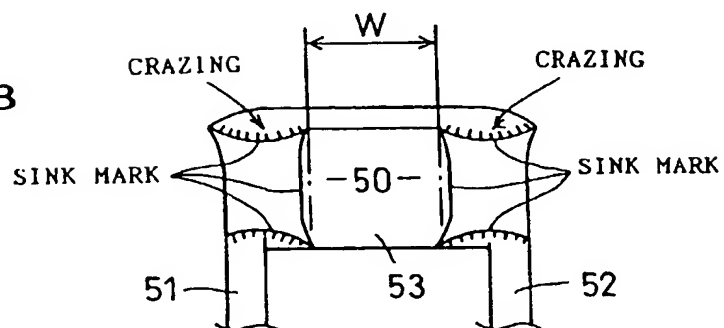
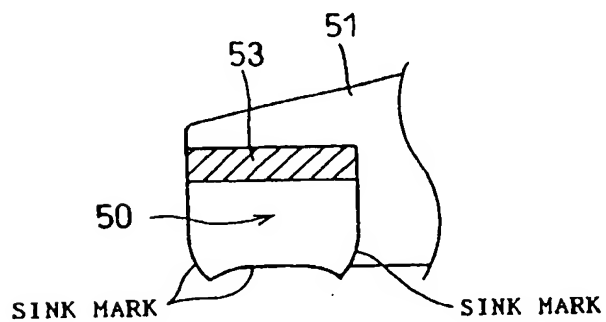
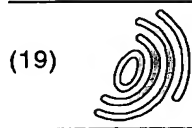


FIG. 8C





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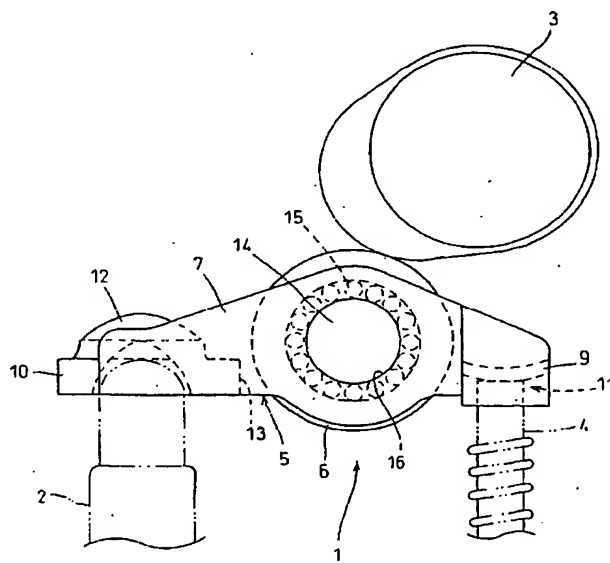
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FIG. 1



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EUROPEAN SEARCH REPORT

Application Number
EP 00 11 1433

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The present search report has been drawn up for all claims			
Place of search		Date of completion of the search	Examiner
THE HAGUE		23 April 2001	Paquay, J
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X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	

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The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 23 April 2001	Examiner Paquay, J
<p>CATEGORY OF CITED DOCUMENTS</p> <p>X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document</p> <p>T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document</p>			

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